WORK WITH MINERALS FOR LITTLE CHILDREN.

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THE work which is here reported was chosen primarily because of children's pleasure in collecting and owning stones, and because the recognition of the common minerals is an essential basis for intelligent work in geography. Several different kinds of work contributed to the better realization of the subject. Reading, writing, mathematics, and manual training aided in the development of the children's plans in much the same way that these subjects would be utilized by an adult in doing a piece of work. When an architect plans a building, he makes his drawings, estimates his strains, writes his letters, gets his information from books; and because he is not in the process of being educated, these parts of a piece of work are unclassified; he is making a house plan. The group of children whose work is reported were trying to classify a collection of pebbles from the lake shore. They made boxes from cardboard to hold the stones; they wrote records of experiments and compared notes; they read to find what other children had done in play similar to theirs, and to get directions for carrying out experiments which they themselves could not plan. Because they are in the process of education, their work is divided, and this part is called manual training, that part number; this recitation reading, and that one writing.

The work was done by a group of children in the University Elementary School, half of whom were beginning first grade, the other half beginning second grade. The series of lessons occupied, approximately, one hour daily for six weeks. The first stones to be classified were quartz, since they were most attractive on account of their sparkling whiteness. Each stone was tested; if it would scratch a piece of glass, the children identified it as quartz. Regarding those which remained, questions arose as to what they were called. A series of experiments was made to determine this. Most of the children were familiar with lime as

the chief ingredient of mortar. At the teacher's suggestion, they put some acid on pieces of lime, and discovered that in every instance this caused effervescence. They tested the mortar with acid, and found that it too effervesced. Thus they established a means for discovering the presence of lime.[1] When they tested one of their stones and found effervescence, they understood that it contained lime, and they were given the name "limestone." They proceeded to sort out the limestone in their collection.

The next step was to label both the quartz and the limestone. The older children wrote the labels for themselves and for the younger group. This necessitated a writing of the words "limestone" and "quartz" some twenty times, and for the younger group it required frequent recognition of the written words during the process of labeling.

Another day, as work to be done alone at their desks, the older group were given a glass rod and a shallow dish containing a little hydrochloric acid; also a plate on which were substances consisting mainly of lime. They were left to test these materials and write their results upon the blackboard. The new words which they would need in writing were the names of the materials tested, and a list of these was put upon the blackboard for reference. At the end of the period the record was examined with the children, and both subject-matter and written form were discussed. Any differences of opinion regarding results were settled by trying the experiment again. These details in regard to unsupervised occupation are given simply to illustrate a type which in its nature is adapted to independent work. The result desired was independent judgment of each child; hence it was reasonable to work alone rather than in a group. The training in skill and carefulness which comes from the handling of materials in experimentation is very great; therefore each child should have his own set of materials and time to do the work alone, while the writing of the result summarizes the experiment in the child's mind. In this case the seat work was more valuable than a recita-

[1] The effervescence, of course, is not conclusive evidence of lime, but of some carbonate; the general appearance of the stone taken with the fact of effervescence was sufficient in most cases to enable them to identify the stone as limestone. —[EDITOR.]

tion. The distinctive value of seat work needs recognition. It is too often looked upon as an unmitigated evil to be endured only because of the necessity for economizing the teacher's time. However, to make unsupervised work most effective it must be followed each time by intelligent criticism.

After their own experimentation, the children read the printed record of another group who had tested the same substances:

We went hunting.
We did not take a gun.
We took acid.
Guess what we were hunting for.
We found it in marble and limestone.
We found it in bones, shells, and chalk.
We found it in lake water.
We found it in the soil in our school yard.
"Lime seems to be in a great many places," said Charles.

The children were shown some beautiful specimens of coral as typical products. They were much interested in them, delighting in their beauty and their resemblance to common things. The group made the following account of coral in order to tell the third grade what fun they were having:

CORAL.

(WRITTEN BY FIRST-GRADE CHILDREN TO SEND TO THE CHILDREN OF THE UPPER PRIMARY GRADE.)

We are studying coral.
We wanted to tell you something about it.
The coral is the skeleton of an animal.
This animal is called a polyp.
It lives down in the sea.
Often it is about as big as a pinhead.

Sometimes it is much larger.

It fastens itself to a rock.

The polyp's children grow on top of the polyp or the side of it.

They grow together in bunches.

After a while the animals in these bunches die.

The hard inner part is left.

This is the coral.

We had some coral that looked like trees with snow on them.

Some people think this kind looks like the horns of deer.

There is some coral that is round with funny little veins.

Some people say this looks just like a man's brain, only it is white.

There is a kind that is yellow.

It looks like cauliflower.

The red coral looks like firecrackers.

All the coral has lime in it.

The children began to make the account collectively, but at the end of fifteen minutes, when it was time to go home, the result was haphazard and incomplete. At home two of the children dictated an account of the coral without help or suggestion. These accounts were written upon the board and criticised by the children wherever they thought them not intelligible. This critical reading by the children of what they have written is urged as valuable training, not only in English, but also in clear thinking. The child holds in mind his audience, and there is a stimulus to complete expression similar to that which is lent to oral expression by the presence of a listener.

Much self-consciousness and the ensuing timidity may be avoided by making the very first writing an expression of opinion rather than a test of skill in reproducing a word which is not a genuine expression of thought. This was illustrated by the younger group as follows: One of the older children asked what coral was made from. In answer, both the older and younger groups were sent to the blackboard, and after a piece of coral had been tested with acid, they were asked to write the name of its material. The older children wrote at once the word "lime," and one of the younger children attempted it. He was helped to write the word, and a second piece of coral was tested. This time all the children, with one exception, attempted to write it. The results were crude, sprawling, and often unrecognizable; but the attempt was freely made. The testing of the coral was repeated with each of the seven varieties, and each time the child wrote what he inferred from the result of the test. Thus every repetition in writing was an expression of individual opinion. It was the first time they had been asked to write anything, and this word they had seen many times both on their labels and upon the blackboard. When an opinion is the matter in hand, the writing becomes incidental to it, and the child is conscious of trying to say something rather than to produce an effect.

Among the pebbles we found some geodes containing quartz crystals, but these were so small as to be unrecognizable in form. Therefore large and more perfect crystals of quartz were brought to the class. These included smoky, rose, and milky quartz, topaz, and amethyst. Because these all scratched glass the children identified them as quartz.

They read the following reading-lesson printed for a former group of children and partly composed by that group:

QUARTZ.

I.

One day some children went to the lake shore.
They found many kinds of pebbles.
Some of the pebbles were white and smooth.

They sparkled in the sunshine.

They were harder than glass.

They scratched glass.

These were quartz pebbles.

All quartz is hard, but not all quartz is white.

Some is pink, some is brown, some is purple, and some is yellow.

II.

Have you ever seen quartz crystals?

A little boy said: "They look like icicles!"

Do they?

A little girl said: "They look like fairy church spires!"

What do you think they look like?

Wonderful fairies must live in the ground!

We find so many kinds of crystals in it.

Some look like sheets of paper.

Mica crystals look like that.

Some are cubes.

Some are brick-shaped.

Some are pyramids.

III.

A little boy thought that white quartz crystals were glass.

Was he right?

Rub some sand on glass.

It scratches the glass like quartz.

Sand is little grains of quartz.

Men make glass of quartz sand and lime.

They put sand and lime in big clay jars.

They melt the sand and lime in the fire.

Then it looks like molasses.

They put a long tube like a horn into the soft glass.

With this tube men can blow it into the shape of bottles, vases, and lamps.

Quartz is not glass.

But glass is melted quartz with lime in it.

Illustrations of the crystal forms mentioned in II were shown by specimens of galena, fluorite, calcite, mica, and finally by some large maple-sugar crystals. The children tried to find out what the last mentioned crystals were, using the acid test and the glass; but both failed. One child smelled them, and great was the astonishment of the entire group upon tasting these crystals.

They were enthusiastic to make sugar crystals, and the directions for work were given in writing whenever these were sufficiently simple. Necessary explanations were thrown in orally.

When the crystals were made, the children composed the following recipe, which applies equally for making crystals of salt, alum, bichromate of potash, and copperas, from all of which good results may be obtained:

RECIPE FOR SUGAR CRYSTALS.

Take some cold water.

Add sugar until no more will dissolve.

Put the water over the fire to boil.

More sugar will dissolve in the boiling water.

Again add sugar until no more will dissolve.

Then set the dish where it will cool.

In two days the crystals will come.[2]

[2] Two years ago, when we made sugar crystals for the Christmas tree decorations, we received information from a wholesale rock-candy manufactory which was of great value. Upon request, this information is reprinted from a back

In order that the children might see a greater variety of crystals, the class spent an hour in the crystal exhibit at the Field Museum, where they gained a much better idea of the definiteness of form and the beauty of crystals.

While we were in the museum we saw some fine examples of fossils, and the children were interested in recognizing the "pictures" on them. When later we found some little fossils on the lake shore, their delight was still greater. The teacher was curious to know how they supposed the impress was made upon the stone. One child only thought that the Indians had made it. Most of them thought the pictured object fell upon the stone, but two of the children without suggestion thought out the actual process. The fact that they had made limestone in a previous lesson gave the clue, for they could think of limestone as hardened mud. In order to test the theory of these two children, each child made upon a lump of clay an impression of a shell or leaf or flower and left it to harden. While this result proved nothing, it strengthened the possibility of a similar method of fossil formation.

For the purpose of binding together in the minds of the children partial results, fragmentary discussions, and individual opinions, the following reading-lesson was written. It summarized the work of several days.

number of the ELEMENTARY SCHOOL TEACHER, now out of print.

Forty pounds of sugar.
One gallon of water.
Stir only until sugar dissolves.
Boil to 234° F.
Keep at a temperature of 70° F. or above for three days.
Avoid any jarring.

The first necessity for attaining large and clear crystals is to use sufficient material, so that a considerable weight may be produced. Occasionally thermometers vary slightly, so that 234° F. does not produce the proper density, but this may be discovered in about five minutes after the syrup has been poured out to cool. By that time a coating has formed on the top which if rough and irregular indicates successful crystalization. If it appears smooth and glassy, the syrup must be boiled and brought to a temperature two or three degrees higher than before.

FOSSILS.

There are some wonderful stones in the Field Museum.

They are called fossils.

Some have the print of fern leaves on them.

Some have the print of fishes on them.

One has the print of a palm leaf.

We found some small fossils on the lake shore.

They have the print of shells on them.

These fossils were in limestone.

We wondered how the picture was made.

We thought the shell fell on the stone and left its print.

But we could not press shells into hard stones.

We remembered that when we made limestone, it was first mud then it hardened into stone.

We thought the shell must have fallen on the mud and made a print; then the mud must have hardened into stone.

We made prints of leaves and shells and flowers in clay.

It only took one night for this clay to harden; but the fossils were made thousands and thousands of years ago.

They read with much pleasure the following story, written by Flora J. Cooke.

THE STORY THE FOSSIL FERN TOLD.

Once a family of ferns lived in a forest.

They did not care for the bright sun.

They liked the cool shade under the trees.

They liked the moist soil by the forest lake.

One little fern grew close to the edge of the water.

She bent down toward the waves.

The waves rolled up toward her.

For a long time they did not reach her.

But after a while great storms came on the lake.

The water rose higher and higher.

Fine, soft mud came with each wave.

It covered the fern and all her family.

Year after year the storms came.

The mud grew deeper and heavier over the fern.

Do you think anyone ever saw the fern family again?

Many years after a man came to the forest.

All the old trees were dead, but a few of their grandchildren were there.

The lake had gone away.

But the old father river was not far away.

The soft mud could not go away.

But it, too, had changed.

It was now hard rock.

The man knocked upon the rock with his hammer.

Then the rock gave a leaf from his stonebook.

There was a picture on it.

It was a picture of the little fern.

There it was, the leaflets, midrib, and veins.

The man could read the stone's story.

It told him how the fern grew by the forest lake;

how the waves covered it with mud; and how the mud hardened into stone.

Can you read the stone story of the fossil fish?

As soon as the pebbles were classified, the children needed a place in which to keep them separate. We planned a box which should hold four cubic inches. After they had some knowledge of kinds of stones, we counted eleven varieties which we wanted to keep; namely, sandstone, limestone, quartz, granite, chert, pudding stone, marble, greenstone, sugar crystals, fool's gold (iron pyrites), and also shells. We made twelve small boxes and then a large one to hold these. The children experimented to see which was the best arrangement of the boxes, whether three by four, or two by six, or twelve by one. Each child chose his own way and made the pattern for this large box. When the pattern was completed, the children transfered it on to bristol board by means of carbon paper. Because of the strain upon the large box, strips of soft sheepskin were used to fasten the corners together, and instead of sewing or gluing these, brass-headed paper fasteners were used as more secure and more sightly. The total expense of each set of boxes was something like three cents.

The number relations and the geometrical conceptions which were applied in the construction of the boxes were so numerous and so well adapted to children of this age that they are enumerated below. They are: the making of a four-inch square (repeated twelve times); the idea that opposite sides of a rectangle are equal and parallel; the fact that two fours are eight (used in cutting binding-paper for the corners of each box); use of one inch, one-fourth inch, and one-eight inch (needed in making large box); conception of four cubic inches, one cubic inch, and the relation of numbers from one to twelve. The problems which arise are not only varied and well adapted, but are so frequently repeated as to furnish sufficient drill to fix them in mind.

This series of work upon the stones furnished a considerable amount of independent work. The younger group spent one half-hour daily for five weeks in the making of the small boxes.

The older children made a blank-book with alphabetically arranged pages like a dictionary. As soon as new words were gained in writing, a copy of them was put into this book for reference. The making of these books and the use of them occupied approximately six periods. The testing of the materials for lime and the making of the imitation fossils required two periods. One period was planned in which the children were to make the crystal forms in clay and color them as a partial record of the Field Museum trip, but time did not permit.

The following directions for the making of the small boxes were written to take the place of oral directions:

DIRECTIONS FOR MAKING SMALL STONE BOXES.

I.

Make a four-inch square.

Find the upper left corner.

Make a dot one inch from this corner on the left edge.

Make a dot one inch from this corner on the upper edge.

Make a dot one inch from the other corner on the upper edge.

Make a dot one inch from the other corner on the left edge.

Make a dot one inch from each corner on the right edge.

Make a dot one inch from each corner on the lower edge.

Find the dots that are opposite.

Draw a line between the opposite dots.

Cut out the square in each corner.

Lay your ruler on the lines that you see.

Then fold the four rectangles upward.

II.

The corners of the box are open.

Cut a piece of[3] binding-paper two inches long.

Fold the short edges of the binding-paper together.

Place the crease at the corner of the box.

Fasten the corners together with this binding-paper.

Written directions for work which is to be done furnish a valuable form of reading, in that reading appears to the child in its legitimate function, namely, telling something that he needs or wants to know — quite different from that well-known type: "This is a cow. Do you see the cow? I see the cow;" and different, too, in its appeal from some less obviously empty remarks of little more value or interest to a group of intelligent children, which are nevertheless to be found in some magnificently illustrated and modern first readers. In the second place, the reading of directions is valuable because it demands clear imaging in order that the work may be done. It has just the value which it claimed for the well-known "Action Sentences," with the added virtue that this thing needs to be done. It is a part of a reasonable plan which the child has in mind.

This particular subject offers abundant material for reading and of a nature particularly suitable for little children. In any subject in which the same process is repeated many times, or where one phenomenon is seen again and again, or where a means of classification is used frequently, the very repetition of the acts themselves causes a repetition of statement, hence a small vocabulary of often recurring words. If the repetition of words necessary in the beginnings of reading may be brought about by the

[3] The corners were fastened by passe-partout paper, which may be gotten at any picture-framing establishment.

recurrence of a result seen from a new standpoint each time, the drill becomes of great value.

The foregoing lessons have been reported in some detail only with the hope of illustrating some principles which seem important as underlying method, namely, that children shall work upon a subject of genuine interest to them: that this subject shall have permanent value as educative material; that each child shall have an opportunity to work independently; that the problems of reading, writing, and number shall arise from the actual needs of the work; and that this subject shall in some way serve to make this group of children more closely in touch with some other group in the school community.

REFERENCES: Crosby, *Common Minerals and Rocks, Tables for the Determination of Common Minerals;* Dana, *Minerals and How to Know Them, Manual of Mineralogy, Crystallogy, Corals and Coral Islands;* Davis, *Physical Geography,* pp. 99–105, 224–30; Heilprin, *The Earth and its Story;* Geikie, *Text-Book of Geology;* Jackman, *Nature Study,* pp. 71, 97, 133, 176, 219, 257, 301, 341, 390, 436; Ruskin, *Ethics of the Dust;* Seeley, *The Story of the Earth;* Shaler, *First Book in Geology;* Scott, *An Introduction to Geology;* Tarr, *Text-Book of Geology.*

Stories for children: Flora J. Cooke, "The Story of the Pudding Stone" and "Sisyphus," from *Nature Myths and Stories for Little Children;* "The Donkey and the Salt," Æsop's *Fables;* Frank Dempster Sherman, "Wizard Frost."